Relation between the level of self-mutilation and the concentration of fecal metabolites of glucocorticoids in captive chimpanzees (Pan troglodytes)

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The influence of stress in an environment, according with the behavioral and endocrine variables of primates, are increasingly being studied by a diversity of authors, and have shown that abnormal behaviors associated with increased glucocorticoids may be directly related with the impairment of their well-being. In this work were used 22 adult chimpanzees (Pan troglodytes), 11 males and 11 females, kept in captivity in three different institutions. All animals had their behavior registered by focal session using a 30 seconds sample interval, during six months, totaling 4,800 registries per each animal. During this period, fecal samples were collected 3 times a week for the extraction and measurement of the concentration of fecal metabolites of glucocorticoid by radioimmunoassay. Of the total observed, stereotypical behaviors represented 13.45±2.76%, and among them, self-mutilation represented 38.28±3.98%. The animals were classified into three different scores, according with the percentage of body surface with alopecia due to self-mutilation. It was found a positive correlation of high intensity between the scores of alopecia due to the observed mutilation and the average concentrations of fecal metabolites of glucocorticoids. This result strongly suggests that this measurement of self-mutilation in a chimpanzee can be used as an important auxiliary tool to evaluate de conditions of adaptation of an animal in captivity, functioning as a direct indicator of the presence of chronic stress.

INDEX TERMS: Chimpanzee, Pan troglodytes, self-mutilation, glucocorticoid fecal metabolites, captivity.
fecaís de glicocorticoides por radioimunoensaio. Os comportamentos estereotipados representaram 13,45±2,76% do total observado, sendo que dentre estes comportamentos a automutilação representou 38,28±3,98%. Os animais foram classificados em três graus diferentes, de acordo com o percentual da superfície corpórea com alopecia decorrente da automutilação. Foi encontrada uma correlação positiva de intensidade forte entre os graus de alopecia decorrente de mutilação observados e as médias de concentrações de metabólitos fecais de glicocorticoides. Este resultado sugere fortemente que esta graduação de automutilação de um chimpanzé possa ser utilizada como uma ferramenta auxiliar importante nas avaliações das condições de adaptação do animal ao cativeiro, atuando como um indicador indireto da presença de estresse crônico.

TERMOS DE INDEXAÇÃO: Chimpanzé, Pan troglodytes, automutilação, metabólitos fecais de glicocorticoides, cativeiro.

INTRODUCTION

For decades the concern about the effects of the interaction between the environment and the organisms has held the attention of researchers Worldwide. The question of how to define and quantify animal welfare is still under constant debate.

Typically, for vertebrates, the habitats are not static and the animals have to adapt to situations predicted by physiological, morphological and behavioral changes. Components that are not predictable promote the so-called “state of emergency”, which results in changes in the endocrine and metabolic parameters of an organism (Möst & Palme 2002).

Captive environments show commonly restricted and invariant stimuli (Paquette & Prescott 1989) and are largely responsible for the development of chronic stress (characterized by prolonged periods of high concentrations of glucocorticoids) or intermittent (Carlstead et al. 1992). This condition can have high costs for the animals, such as decreased individual fitness by immune suppression and tissue atrophy, decreased reproductive function (Gronl et al. 2005, Peel et al. 2005) and promote behavioral changes, also known as stereotypies (Mason 1991, Carlstead et al. 1992, McBride & Cuddiford 2001).


The stereotypical behaviors may manifest themselves differently depending on the species or the individual (Coleman & Maier 2010, Würbel et al. 2006). Shepherdson (1998) stated that stereotypies can be quantitative, such as hyperactivity, or qualitative. As examples, one can cite the behaviors that the individual would not show in nature, such as walking aimless, false chewing, drinking water excessively, foraging even after feeding (Mason 1991), masturbation, food regurgitation followed by re-ingestion (Gould & Bress 1986, Dickie 1998), coprophagy (Akers & Schildkraut 1985), pacing (Boorer 1972) and self-addressed, such as self-mutilation.

Self-mutilation has been widely studied as an abnormal behavior in chimpanzees (Birkett & Fisher-Newton 2011, Ferdowsian 2011) and quantitative studies of these behaviors can demonstrate the effects of captivity among this specie (Birkett & Fisher-Newton 2011).

The association of behavioral and endocrine methods of study enables greater efficiency for the evaluation of stress intensity (Sgai et al. 2010). The concentration of glucocorticoids in plasma is widely used as one indicator of the presence of stressors. In light of the fact that blood sampling may also be dangerous or even impossible in some zoo and wildlife species, noninvasive methods for measuring glucocorticoids or their metabolites seem desirable for assessing adrenocortical function in animals (Palme 2005a) and has been used with primates (Bahr et al. 2000, Murray et al. 2013).

Noninvasive methods of measuring fecal steroid metabolites to assess an animal’s endocrine status are now widely used to investigate hormone–behavior relationships, as well as questions in the fields of reproduction, animal welfare, ecology, conservation biology, and biomedicine (Palme 2005b).

This way, the objective of this study was to analyze a possible relation between the level of self-mutilation and the concentration of fecal metabolites of glucocorticoids in captive chimpanzees.

MATERIALS AND METHODS

In this study 22 adult chimpanzees (Pan troglodytes) were used, 11 males and 11 females, kept in captivity. They came from three different institutions, two zoos and one private facility, the environmental enrichment program of which was not followed in the routine management of the animals. At the zoos the animals were kept in pairs, in areas of about 100m², and at the private facility, they were kept in individual enclosures, with areas of 25m². The diet at those three institutions was based on fruits, vegetables and protein items, offered twice a day, every day.

All chimpanzees had their behaviors recorded by focal session using a 30 seconds intersample interval (Altmann 1974, Martin & Bateson 1993), with recordings every 30 seconds in 30-minutes sessions, in the morning (8:00 – 11:00 a.m.), time of greatest activity of the animals (determined by implementation of peak activity), totaling 40 hours for each animal with 4,800 records during six months. All recordings were made in spreadsheets by a single observer, during exposure of the animal to the public, three times a week.

Individual ethograms were prepared, however for this work, just information related to self-mutilation were used. The degree of self-mutilation was classified into three scores, according to the percentage of alopecia along the body surface, ranging from 0 to 2 (Fig.1):

- Score 0: Absence of areas without hair;
- Score 1: Areas with alopecia in up to approximately 30% of body...
From the 4,800 behavioral records for each chimpanzee, a repertoire was obtained of 19 different behaviors. The abnormal behaviors observed had a frequency of occurrence of 13.45±2.76%, and among them, self-mutilation represented 38.28±3.98% of those abnormal behaviors.

From the 22 chimpanzees studied, 20 presented some level of self-mutilation and were classified as: 2 animals with score 0; 15 animals with score 1; and 5 animals with score 2.

The quality control of the assays performed to measure the concentrations of glucocorticoid fecal metabolites showed the following results: coefficients of variation inter-assay: 12.75%, intra-assay: 2.21% and minimum sensitivity detected: 2.55ng/dl.

Mean concentrations of glucocorticoid fecal metabolites found in three different scores of self-mutilation were: 34.65±9.35, 90.34±29.08 and 138.82±38.45ng/g of dry feces for scores 0, 1 and 2 respectively, showing significant differences (Fig.2).

It was found a positive correlation of high intensity (0.82), p<0.001 between the means of glucocorticoid fecal metabolites concentrations and the different scores of self-mutilation.

Fig.2. Means and SD of concentrations of fecal metabolites of glucocorticoids in different scores of self-mutilation in captive chimpanzees (*Pan troglodytes*). (*Different superscript letters denote significance at P<0.05).*
DISCUSSION
Self-mutilation presented the highest frequency of occurrence of abnormal behaviors (mean 38.28% ± 3.98), in contrast with the findings of Ferdowsian (2011), in which coprophagy was the abnormal behavior with a higher prevalence. The frequency of occurrence of abnormal behaviors (13.45% ± 2.76) can also be considered higher comparing to the findings by Bloomsmit and Lambeth (1995) and Ferdowsian (2011) however, no work had previously related the occurrence of abnormal behaviors with concentrations of glucocorticoids. The high positive correlation found between the means of concentrations of glucocorticoid fecal metabolites and the different scores of self-mutilation, suggested that this kind of lesion can be associated to a chronic stress situation and consequent dysfunctional behavior. These results showed that chimpanzees subjected to captive environments with poor quality stimuli may develop a pattern of qualitative stereotypical behavior as described by Swaisgood and Shepherdson (2006) and this can be directly related to the endocrine-physiological response of the animal against a condition of difficult adaptation. It could represent the specie adaptive-biological-cost due to the conditions of captivity.

In this study, it was not compared the different levels of mutilation according to age, sex or animal individual history, based in Birkett & Fisher-Newton (2011) when he found no difference between these variables for the study of abnormal behaviors in chimpanzees. To our knowledge, this is the first study establishing a relationship between cutaneous lesions, stereotypical behavior and concentrations of glucocorticoid fecal metabolites in chimpanzees, suggesting a chronic stress captive related situation.

CONCLUSIONS
In this study was found a relationship between the means of concentrations of glucocorticoid fecal metabolites and the different scores of self-mutilation.

These results strongly suggest that the level of self-mutilation can be used as a tool to help important evaluations of the conditions for animal adaptation in captivity, acting as an indicator of chronic stress in chimpanzees.

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